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MODEL 429
DEFIBRILLATOR ENERGY METER

OPERATING and SERVICE MANUAL

R. H. DEMPSEY MANUFACTURING COMPANY

a division of NEURODYNE - DEMPSEY, INC.

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MANUAL CHANGES

Model 429
DEFIBRILLATOR ENERGY METER
Manual printed Jan. 1972

MAKE ALL CORRECTIONS IN THIS MANUAL ACCORDING TO ERRATA BELOW.

-New Items.

[redacted]

ERRATA

Page 6-2, Table 6-1:
Change C20 to 2.2nf. Sprague 192P-22292.

Page 6-3, Table 6-1:
-Add D13, Description "1N5241", TR.to 2.
-Add D14, Description "Same as D13".

Page 6-7, Table 6-1:
Change R66 to 270K ±5% 1/4 W, Composition, TR. to 1.
Change R68 TR. to 2.
Change R70 to 178K ±1% 1/4 W, Metal Film, TR. to 2.
Change R71 to 158K ±1% 1/4 W, Metal Film, TR. to 4.
Change R72, Description "Same as R71".
Change R73, Description "Same as R71".
Change R74, Description "Same as R71".
Change R75, Description "Same as R70".
Change R79 to 200K ±5% 1/2 W, Composition, TR. to 10.
Change R80, Description "Same as R79".
Change R81, Description "Same as R79".
Change R82, Description "Same as R79".
Change R83, Description "Same as R79".
Change R84, Description "Same as R68".
Change R85, Description "Same as R79".
Change R86, Description "Same as R79".
Change R87, Description "Same as R79".
Change R88, Description "Same as R79".
Change R89, Description "Same as R79".
Delete R90.

MANUAL CHANGES

Model 429
DEFIBRILLATOR ENERGY METER
Manual printed Jan. 1972

Make all corrections in this manual according to errata below.

←New item.

ERRATA

Page 5-3, Paragraph 5-10:
Paragraph should read: "Connect the DVM common to TP-1 and the other lead to TP-3 (see figure 5.2 and 5.3 for test point location.) The DVM should read between -15.1 and -15.0 volts. Adjust R8 until the output is within this range. Move the DVM hot lead to TP-2. This voltage should be positive and the same magnitude as TP-3 within ± 1% (± 0.15 volts.)

Page 5-9, Figure 5.4:
Change R7 to 4.3K, R9 to 3K, R14 and R15 to 10.0K.
Change NOTE to read "All resistors with two digits are ± 5%, three digits ± 1%.

Page 6-2, Table 6-1:
Change C1 TR. to 4.
Change C12 to 0.47 MFD 100V Amperex C281CH/A470K.
Change C14 TR. to 2.
Change C15 to Capacitor 0.0022 MFD 200V Sprague 192P-22292, 1 ea.
Change C17 MFG. NO. to 192P-22492.
←Add C19, Capacitor Mica 300 PF 500V DC, DM-15-301J, 1 ea.
←Add C20, Capacitor Mica 620 PF, DM-15-621J, 1 ea.

Page 6-3, Table 6-1:
Change D4 MFG. NO. to IN961.
Change D5 TR. to 6.
Change D6 MFG. NO. to IN100 and TR. to 2.
←Add D10, Description "Same as D5".
←Add D11, Description "Same as D6".
←Add D12, Description "Same as D5".

Page 6-4, Table 6-1:
Change R5 TR. to 3.

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TABLE OF CONTENTS

		Page
SECTION I, GENERAL INFORMATION		1-1
1.1	Introduction	1-1
1.3	Description	1-1
1.5	Specifications	1-1
SECTION II, INSTALLATION		2-1
2.1	Introduction	2-1
2.3	Incoming Inspection	2-1
2.5	Installations	2-1
2.7	Repackaging for Shipment	2-1
SECTION III, OPERATION		3-1
3.1	Introduction	3-1
3.3	Controls	3-1
SECTION IV, PRINCIPLES OF OPERATION		4-1
4.1	General	4-1
4.3	Energy Content of a Pulse	4-1
4.7	Operation of Model 429	4-2
4.22	Detailed Circuit Description	4-4
SECTION V, MAINTENANCE and CALIBRATION		5-1
5.1	General	5-1
5.5	Calibration	5-1
5.9	Power Supply Adjustment	5-3
5.12	Squaring Circuit Alignment	5-3
5.14	Integrator Adjustment	5-4
5.19	Display Time Adjustment	5-5
SECTION VI, REPLACEABLE PARTS		6-1
6.1	Introduction	6-1
6.4	Ordering Information	6-1

LIST OF ILLUSTRATIONS

FIGURE		PAGE
1.1	Model 429 Defibrillator Energy Meter.....	1-0
3.1	Front and Rear Panel Controls and Functions....	3-0
4.1	Pulse of Arbitrary Shape and Time.....	4-1
4.2	Block Diagram of Basic Concept.....	4-2
5.1	Load PC Board Component Location.....	5-6
5.2	Main PC Board Component Location.....	5-7
5.3	Main PC Board Component Location.....	5-8
5.4	Power Supply Schematic.....	5-9
5.5	Load and Attenuators.....	5-10
5.6	Main Schematic.....	5-11

LIST OF TABLES

TABLE		PAGE
1.1	Specifications.....	1-0
5.1	Characteristic of Model 430 Defibrillator Energy Meter Calibrator.....	5-1
5.2	Test Equipment Required to Calibrate the Model 429.....	5-2
5.3	Input-Output Voltage for Squaring Circuit.....	5-4
5.4	Meter Readings for Various Pulse Widths.....	5-5
6.1	Replaceable Parts.....	6-2

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(Figure 1.1) Model 429 Defibrillator Energy Meter

Table 1.1 SPECIFICATIONS

Power Ranges:	0-40, 0-100, and 0-400 watt-seconds
Load Resistance:	50 ohm ± 0.5%
Pulse Width:	2-20 ms
Accuracy:	± 2% of full scale for pulse width of 2 ms decreasing to ± 7% for a pulse width of 20 ms at 20°C
Temperature Range:	15° to 40° C
Temperature Coefficient:	0.1% / C
Line Voltage:	115 V ± 10% 60 HZ
Output Jack:	B.N.C. output jack with 1000:1 ± 5% attenuation provided on the rear panel for oscilloscope connection

SECTION I

GENERAL INFORMATION

1.1 Introduction.

1.2 This manual contains operating and maintenance instructions for the Model 429 Defibrillator Energy Meter.

1.3 Description.

1.4 The Model 429 Defibrillator Energy Meter is a precision pulse energy measuring instrument, designed primarily for the purpose of verifying or calibrating the output energy from all DC defibrillators. This instrument is portable, accurate, and easy to use.

The operation of the 429 is almost totally automatic, leaving only the range selection and power switch movements to the user. After these are made, the user places the paddles of the charged defibrillator against the input contact plates. The defibrillator is then discharged into the 429 which gives a reading of the delivered energy into the fifty ohm load. The reading is retained by the 429 for a period of five seconds allowing the user ample time for observation.

1.5 Specifications.

1.6 Specifications for the Model 429 Defibrillator Energy Meter are listed in Table 1.1.

SECTION II

INSTALLATION

2.1 Introduction.

2.2 This section contains information on inspection, installation, and repackaging for shipment.

2.3 Incoming inspection.

2.4 This instrument was carefully inspected both mechanically and electrically before shipment. Upon receipt, the instrument should be inspected for physical damage in transit, and the electrical performance should be tested using the procedure outlined in Paragraph 5.4.

2.5 Installations.

2.6 The Model 429 is a complete instrument and is ready to use upon connection to the 115V $\pm$ 10% 60 HZ power source.

2.7 Repackaging for shipment.

2.8 The following is a general guide for repackaging an instrument for shipment.

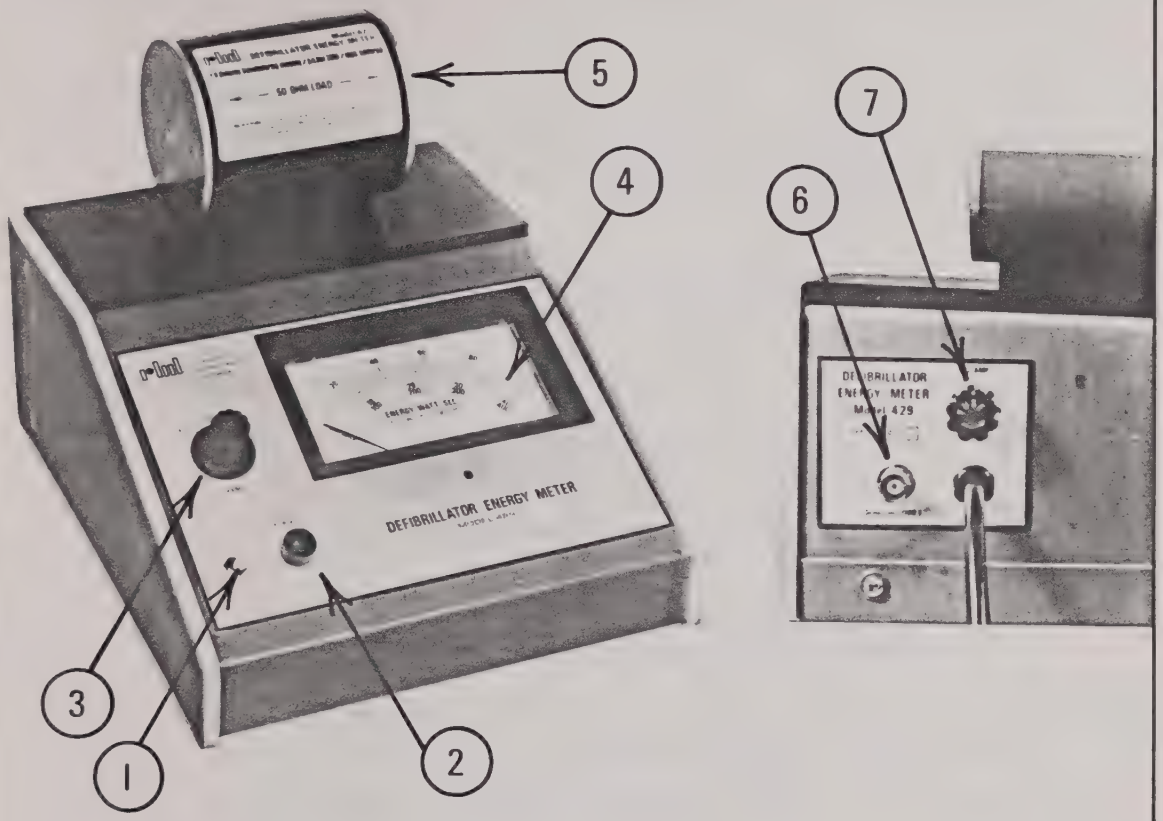
a. Place instrument in original containers if available.

b. If original container is not available, use a heavy carton or wooden box as a container and use strong tape or metal bands to seal it.

c. Wrap instrument in heavy paper or plastic before placing in container.

d. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.

e. Mark the shipping container with "Delicate Instrument", "Fragile", etc.



1.	Power ON/OFF Switch	Turns instrument power on.
2.	Power On Indicator	Lights when power is applied.
3.	Range Selector	Selects the desired meter range.
4.	Meter	Indicates the amount of energy delivered to the load.
5.	50 ohm Load	Provides contacts for defibrillator paddles.
6.	Scope Output Jack	Provides 1000:1 attenuation of defibrillator pulse.
7.	Fuse	Provides fault protection for instrument.

(Figure 3.1) Front and Rear Panel Controls and Functions

SECTION III

OPERATION

3.1 Introduction.

3.2 This section contains information on the operation of the Model 429. It assumes that the unit is operating correctly.

3.3 Controls.

3.4 Front panel controls and indicator and rear panel functions are described in Figure 3.1.

3.5 To measure the output of a defibrillator proceed as follows:

a. Connect the Model 429 and the defibrillator to a source of power and turn the unit on.

b. Adjust the output of the defibrillator to the desired setting following the manufacturers recommendations.

c. Select a range on the Model 429 that corresponds to the output level selected on the defibrillator.

d. Place the defibrillator paddles firmly against the end caps on the load and discharge the defibrillator.

e. Read the energy dissipated in the 50 ohm load on the meter of the Model 429.

3.6 To observe the voltage wave form, connect an oscilloscope to the "scope out" jack on the rear of the 429. Set the sweep speed to 1 ms/div. and the vertical gain to 0.5 V/div., set the oscilloscope to the triggered mode and discharge the defibrillator into the 50 ohm load on the 429.

NOTE: This attenuator is not frequency compensated so the high frequency voltage division is not as great as the low frequency voltage division.

NOTE: Some defibrillators have one of their output leads connected to the chassis (ground). If the paddle that is grounded is connected to the right side of the load on the 429, no output will appear at the "scope out" jack. In this case, reversing the paddles will cause the output to be present.

3.7 Some defibrillators use a transformer in their output. A transformer cannot transfer DC, and as a result, when these defibrillators are discharged, they produce a reverse current that lasts for several seconds when they are connected to the 50 ohm load. If the paddles are removed from the load, a high level RF signal is generated which might affect the reading of the 429 at the high energy levels. If it is determined that this is happening, the paddles should be left in contact with the load until the reading is taken.

SECTION IV

PRINCIPLES OF OPERATION

4.1 General.

4.2 This section contains information on the energy contained in a pulse, one method of measuring this energy, and the circuits used in the Model 429.

4.3 Energy content of a pulse.

4.4 The energy contained in a pulse of arbitrary shape and time duration (Figure 4.1) is given by

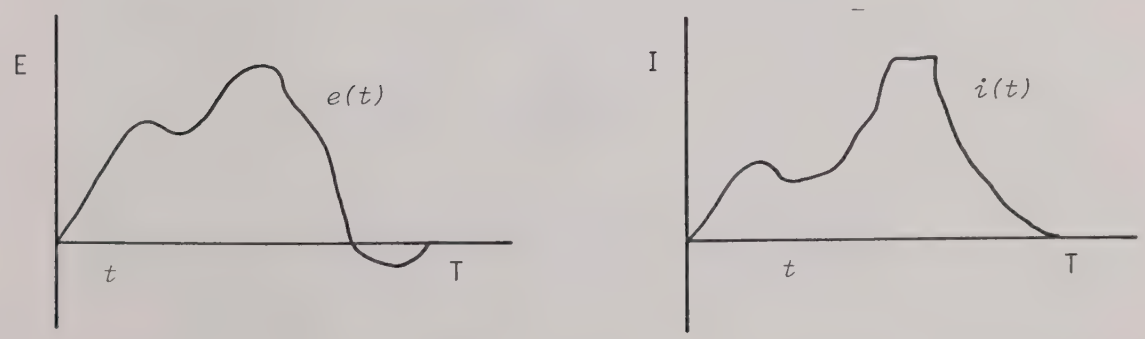
$$W = \int_0^T e(t)\, i(t)\, dt.$$

where W is the energy in watt-seconds

$e(t)$ is the voltage as a function of time

$i(t)$ is the current as a function of time

and T is the time duration of the pulse.



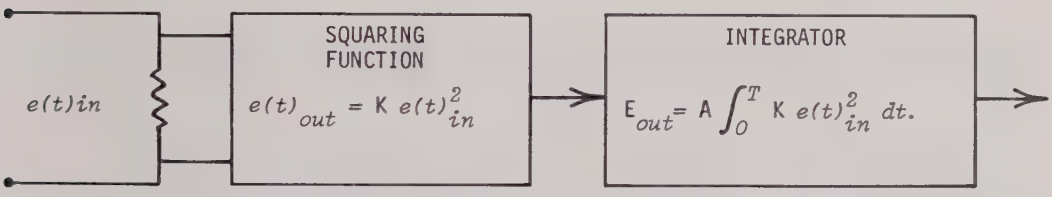
(Figure 4.1) Pulse of Arbitrary Shape and Time

4.5 For the special case where the voltage exists across a constant resistance the energy dissipated in that resistance reduces to:

$$W = \frac{1}{R} \int_0^T e(t)^2 \, dt.$$

where R is the resistance of the load.

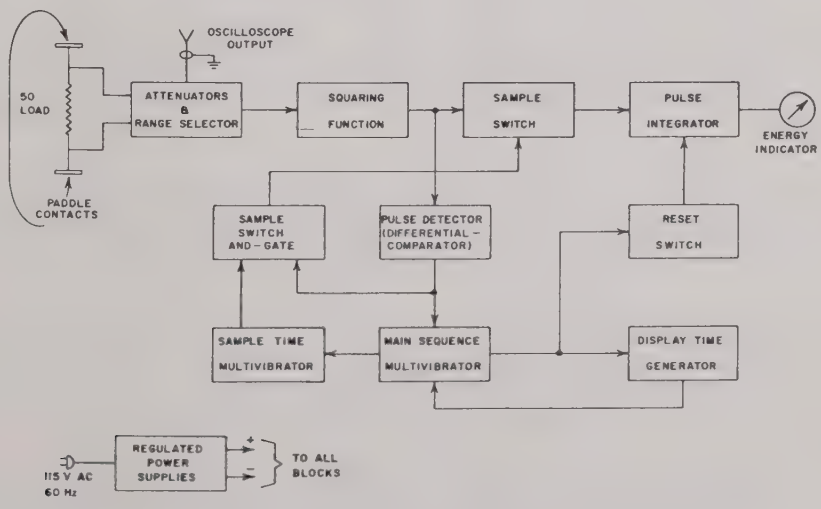
4.6 Thus in order to measure the energy dissipated in a known resistive load from a pulse, first square the voltage and then integrate the resulting functions for the duration of the pulse. This is shown in block diagram form in Figure 4.2 and is basically how the Model 429 operates.



(Figure 4.2) Block Diagram of Basic Concept

4.7 Operation of Model 429.

4.8 A block diagram of the 429 is shown in Figure 4.3 and a description of the circuits are given in the following paragraphs.



(Figure 4.3) Block Diagram of Model 429

4.9 The Model 429 contains 13 major circuits which are the 50 ohm load, attenuators and range selector, squaring circuit, pulse detector, main sequence multivibrator, sample time multivibrator, sample switch AND gate, sample switch, pulse integrator, energy indicator, reset switch, display time generator, and the power supplies. These circuits perform the various functions necessary for the unit to operate.

4.10 50 ohm Load: The 50 ohm load is the standard into which the defibrillator is discharged so the energy can be computed.

4.11 Attenuators and Range Selector: This circuit scales the voltage amplitude down to provide a sample for the oscilloscope output and the squaring circuit.

4.12 Squaring Circuit: The squaring circuit generates the square of the sample voltage. This is the true square and the unit has excellent linearity.

4.13 Pulse Detector: The pulse detector monitors the output of the squaring function; when the amplitude exceeds a fixed level, it initiates the operation of the main sequence multivibrator.

4.14 Main Sequence Multivibrator: This circuit simultaneously starts the sample time multivibrator and display timer generator, and turns off the reset switch. After the start of the sequence, this circuit prevents the reading from being changed by the application of a second pulse before the display time generator has completed its operation.

4.15 Sample Time Multivibrator: This circuit controls the time that the sample switch can be turned on, if an output is present from the pulse detector. This in turn controls the maximum pulse width the unit will measure.

4.16 Sample Switch AND Gate: This circuit turns the sample switch on only when there is a signal present from the sample time multivibrator and the pulse detector. The function of this circuit is to minimize the effect on the output due to the zero offset of the multiplier.

4.17 Sample Switch: The sample switch connects the integrator to the squaring circuit only after it is determined that a pulse is present, and then only during the sample time when a pulse is present. This allows the integrator to be used as an analog storage element as well.

4.18 Pulse Integrator: This circuit integrates the squared function pulse during the time the sample gate is closed; during the remainder of the display time it acts as an analog storage element.

4.19 Energy Indicator: The energy meter reads the voltage stored in the pulse integrator and is calibrated in watt-seconds.

4.20 Reset Switch: When the reset switch is turned off (during the display time) the integrator can integrate the pulse and act as a storage element. When it is turned on, it resets the integrator to zero in preparation for the next pulse.

4.21 Display Time Generator: The display time generator controls the length of time the reading is displayed on the meter.

4.22 Power Supply: The power supply provides + 15 V and - 15 V DC to operate the circuitry.

4.23 Detailed Circuit Description.

4.24 Most of the circuits used in the instrument are well understood and will not be discussed further; however, the squaring circuit and the FET in the + 15 V power supply are unique and will be discussed further.

4.25 Squaring Circuit: The squaring circuit consists of a four-quadrant multiplier A1 and an operational amplifier A2.

4.26 The four-quadrant multiplier is a linear monolithic circuit which operates on the principle of variable transconductance. The output of this unit is a current that is proportional to the product of the two inputs. In the squaring mode the two inputs X and Y are tied together so the output current is proportional to X^2.

4.27 The operational amplifier operates as a current-to-voltage converter producing a voltage that is proportional to the output current from the multiplier. The gain is adjusted so that the output is one tenth of X^2.

4.28 Power Supply FET: The power supply regulator is a conventional series pass type except for the use of the FET to drive the series pass transister. By using a Junction FET the gate can be supplied from the regulated voltage instead of from the unregulated voltage as in the normal case. Also since the gate current is extremely low, the collector resistor of the differential amplifier can be made large for maximum voltage gain. These two advantages allow a single stage of amplification to achieve good regulation and line rejection.

SECTION V

MAINTENANCE and CALIBRATION

5.1 General.

5.2 This section contains information for the maintenance and calibration of the Model 429.

5.3 The Model 429 is all solid state and should need no periodic maintenance except cleaning the case and calibrating the instrument.

5.4 A quick check of the 429 can be made by the following method. Select 100 watt-seconds range on 429. Set the output of a defibrillator to a point near 100 watt-seconds. Allow 20 seconds for the defibrillator to reach full charge. Discharge the defibrillator into the 429 and note the reading. Recharge the defibrillator at the same setting and allow another 20 seconds to reach full charge. Reverse the paddles on the load of the 429 and discharge the defibrillator. The two readings should be within 2% of each other. If the readings do agree, the 429 is functioning correctly.

NOTE: This does not check the calibration of the Model 429.

5.5 Calibration.

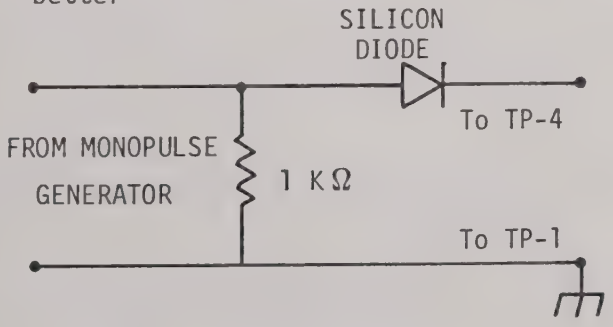
5.6 The calibration of the Model 429 is straightforward and can be done in a laboratory that is set up to do calibration work. To assist in and to simplify the calibration of the unit, the Model 430 Defibrillator Energy Meter Calibrator is available which incorporates all the test equipment functions except the DVM into one unit. The characteristics of the 430 are given in Table 5.1.

Table 5.1 Characteristic of Model 430 Defibrillator Energy Meter Calibrator

DC Voltage Output	Adjustable from + 10 VDC to -10 VDC ± 0.1% full scale. Current 0 - 15 MA.
Monopulse Output on command with push button switch	Amplitude Adjustable from + 10 V to -10 V ± 0.1% full scale. Offset 0 V ± 0.001 V. Width adjustable from 1 MS to 10 MS ± 0.1%.

5.7 The test equipment characteristic required and equipment that may be used is listed in Table 5.2.

Table 5.2 Test Equipment Required to Calibrate the Model 429

EQUIPMENT	CHARACTERISTIC	TYPICAL
Variable Transformer	1 AMP Capacity	Superior Electric Model 2PF10
Digital Voltmeter	4 Digit Capable of measuring 10 V with 1 MV resolution and 0.1% accuracy, or better	HP Model 3440 A
Monopulse Generator	Capable of supplying one positive going pulse of 2 MS duration and 10 V amplitude upon command	Wavetek Model 116
Oscilloscope	0.5 second per division ± 10% or better	Tektronix 545
Reference Power Supply	Provide adjustable output between + 10 V settable within ± 0.1% or better	HP Model 740B
Test Network		

5.8 Remove the bottom from the Model 429 that is to be calibrated by unscrewing the two screws on the rear of the unit and sliding the bottom panel out. Set the unit up-side-down on a protective mat and warm up the unit and the test equipment for about 10 minutes.

5.9 Power supply adjustment.

5.10 Connect the DVM common to TP-1 and the other lead to TP-2. (See Figure 5.2 and 5.3 for test point location.) The DVM should read ± 15 V + 0.1 V. Adjust R8 until the output is within this range. Move the DVM hot lead to TP-3. This voltage should be negative and the same magnitude as TP-2 within 0.1 volts.

5.11 Reconnect the DVM to TP-2 and adjust the Variac from 105 to 130 VAC and note that the output of the supply does not change.

5.12 Squaring circuit alignment.

5.13 The alignment of the squaring circuit can be performed using the following procedure.

a. Connect the hot side of the DVM to TP-5, set the range switch on the Model 429 under test to 100 watt-seconds and connect the output of the reference D.C. supply between TP-1 and TP-4.

b. Set the output of the reference supply to zero.

c. Adjust R24 until the voltage at TP-5 is 0.000 V ± 0.010 VDC.

d. Set the reference supply to +10.00 VDC.

e. Adjust R25 until the voltage at TP-5 is -10.00 VDC.

f. Set the reference supply to -10.00 VDC. The voltage measure at TP-5 should be equal to the voltage when +10.00 VDC is applied at TP-4. If the two voltages are not equal adjust R23 until they are equal.

g. The three adjustments R24, R25, and R23 are interreacting and the procedure b. through e. should be performed until all readings are within 10 MV of their nominal values.

h. Check the linearity of the squaring circuit by applying the voltages in Table 5.3 to TP-4 and reading the voltage at TP-5. The linearity should be within ± 0.5% of full scale (± 0.050 V) and typically within ± 0.2%.

(5.13 continued)

i. If the squaring circuit does not fall within the ± 0.5% linearity, another high adjusting point may be tried, ie: TP-4 9.000 V and TP-5 8.100 volts and steps a. through h. repeated.

Table 5.3 Input-Output Voltage for Squaring Circuit

Input Voltage Between TP-4 and TP-1 (comm)	Output Voltage Between TP-5 and TP-1
± 10.000	- 10.000
± 9.000	- 8.100
± 8.000	- 6.400
± 7.000	- 4.900
± 6.000	- 3.600
± 5.000	- 2.500
± 4.000	- 1.600
± 3.000	- 0.900
± 2.000	- 0.400
± 1.000	- 0.100
0.000	0.000

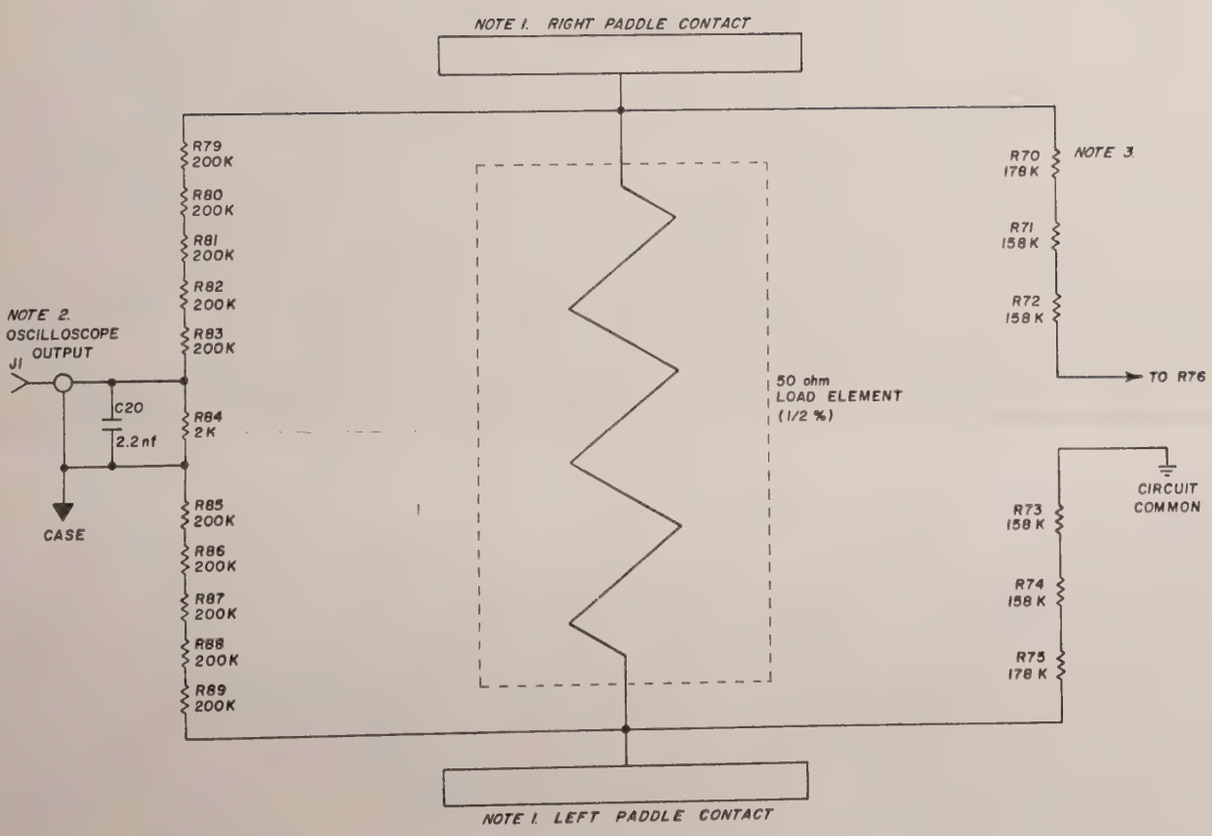
5.14 Integrator adjustment.

5.15 Connect the output of the monopulse generator through the test network if needed to TP-4. Adjust the generator to produce a 2 MS pulse at about 5 V amplitude, at the output of the test network.

NOTE: The test network will be needed if the output of the monopulse generator has a DC offset.

5.16 Turn the Model 429 under test right-side-up and fire the monopulse generator. Using the meter as an indicator, adjust R36 for minimum drift.

5.17 Set the width of the monopulse generator to 2.000 MS ± 0.1% and the output to 10.00 V ± 0.1% at the output of the test circuit when it is connected to the 429. Fire the monopulse generator and adjust R26 until the meter indicates 100 watt-seconds.

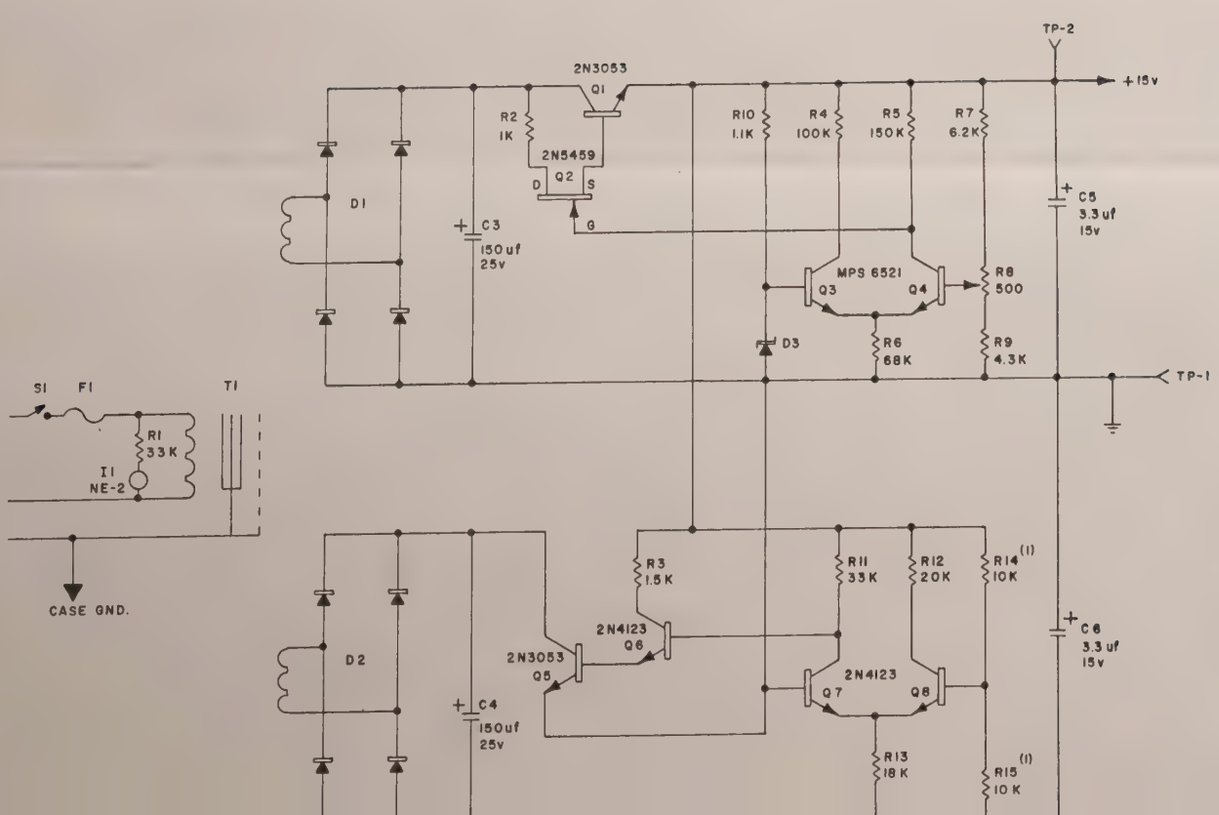


LOAD and ATTENUATORS

FIGURE 5-5

NOTES:

1. FACING FRONT PANEL.
2. ATTENUATION 1000:1 5%
3. RESISTORS R70 - R78 ARE 1%


TP-2
+15v
2N3053
Q1
R2
1K
2N5459
D
Q2
S
G
D1
C3
150uf
25v
R10
1.1K
R4
100K
R5
150K
R7
6.2K
C5
3.3uf
15v
MPS 6521
Q3
Q4
R8
500
D3
R6
68K
R9
4.3K
TP-1
S1
F1
T1
R1
33K
I1
NE-2
CASE GND.
R3
1.5K
R11
33K
R12
20K
R14 (1)
10K
C6
3.3uf
15v
2N4123
Q6
2N3053
Q5
2N4123
Q7
Q8
D2
C4
150uf
25v
R13
18K
R15 (1)
10K

(5.17 continued)

NOTE: This adjustment will have to be made by noting which way the reading is off. Adjust R26 a small amount, then fire the monopulse generator and note the reading again, etc.

5.18 After the adjustment has been completed, check the output at various points to check the readout tracking of the meter (see Table 5.4 for input-output voltages).

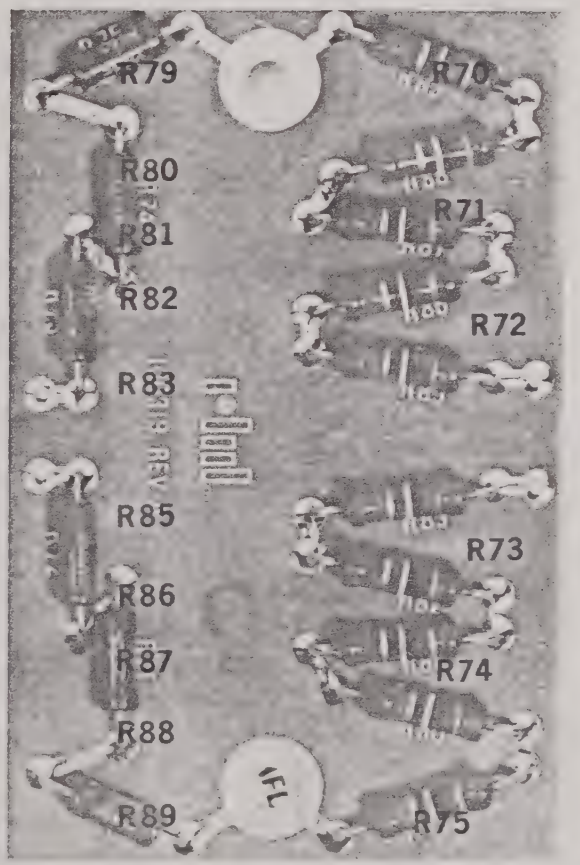
Table 5.4 Meter Readings for Various Pulse Widths

	Input Voltage for Each Pulse Width			
Meter Reading Watt-Seconds	2MS	5MS	10MS	20MS
100	±10.000	6.325	4.472	3.163
90	±9.487	6.000	4.242	3.000
80	±8.945	5.656	4.000	2.828
70	±8.367	5.291	3.741	2.645
60	±7.746	4.898	3.464	2.449
50	±7.071	4.472	3.162	2.236
40	±6.325	4.000	2.828	2.000
30	±5.478	3.464	2.449	1.732
20	±4.473	2.828	2.000	1.414
10	±3.163	2.000	1.414	1.000
0	0	0	0	0

5.19 Display time adjustment.

5.20 Connect an oscilloscope to TP-10 and set the oscilloscope up to be triggered by the monopulse generator. Set the sweep speed to 1 sec. per div. Fire the monopulse generator and measure the time the reset pulse occurs. Adjust R-51 until this times is 5 sec. ± 10%.

5.21 This completes the calibration of the Model 429 Defibrillator Energy Meter.



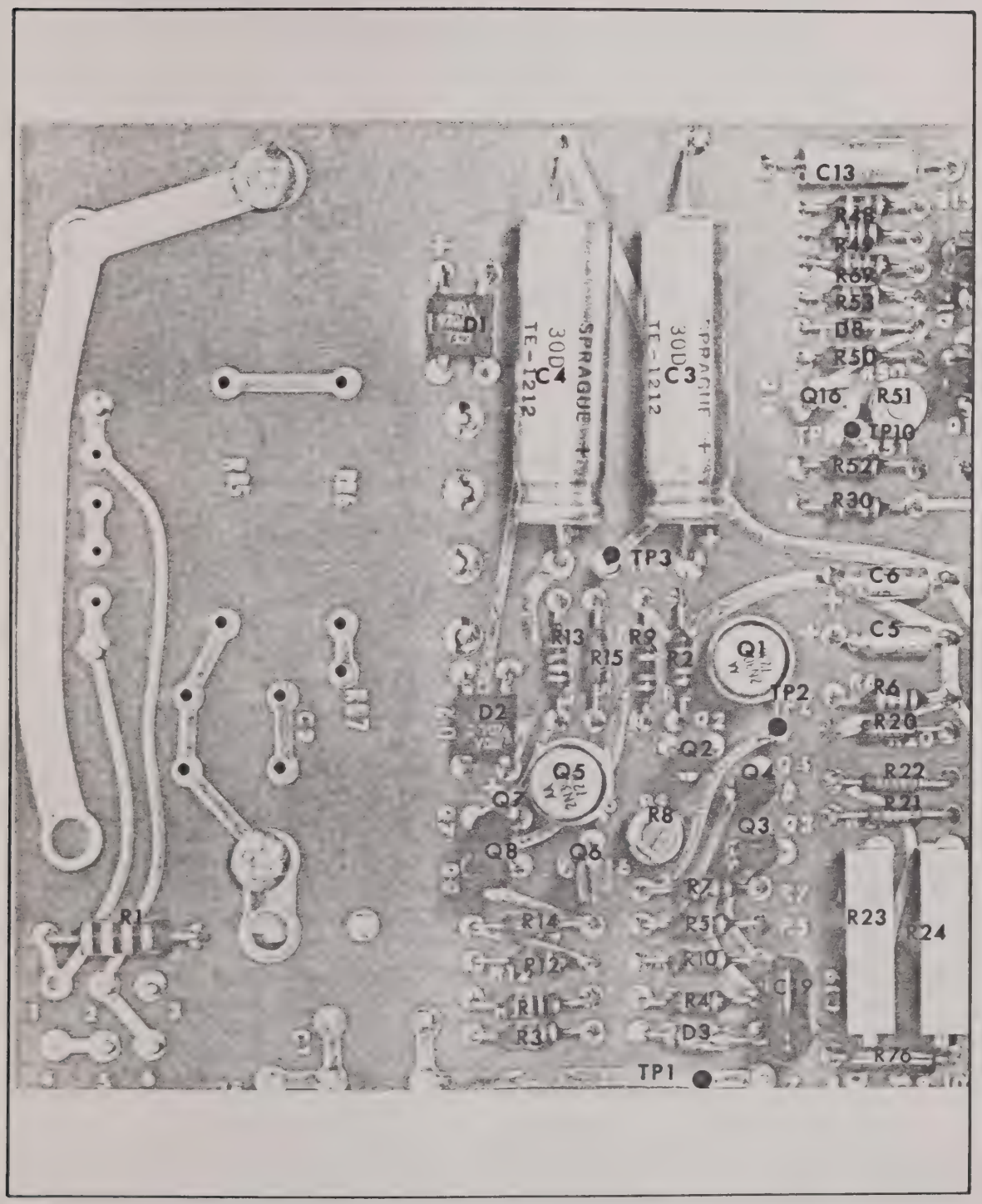
(Figure 5.1) Load PC Board Component Location

NOTE:

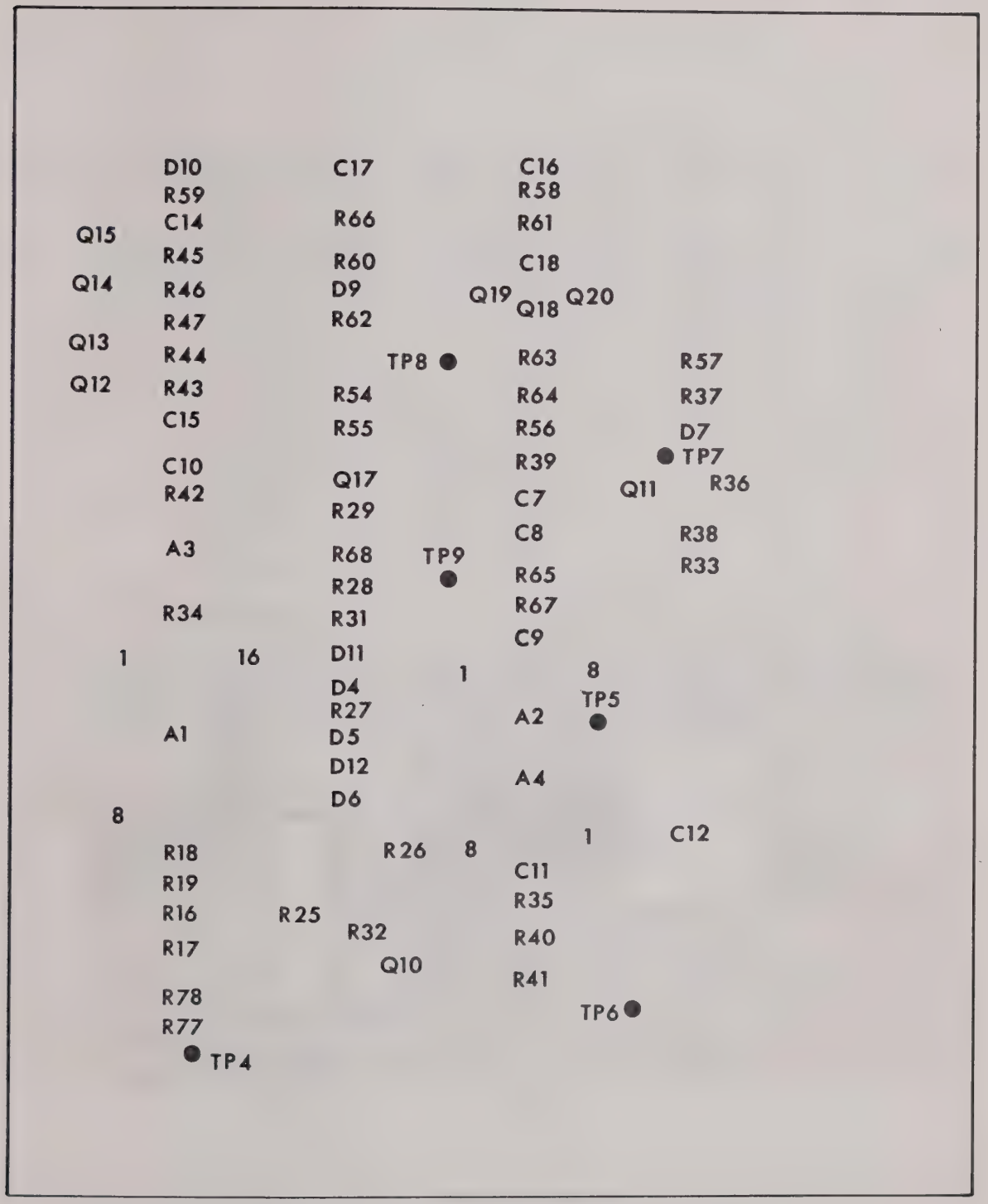
R21 and R22 may be values other than shown on Main Schematic. These values are dependent upon multiplier characteristic variance.

MAIN SCHEMATIC

FIGURE 6-6



(Figure 5.2) Main PC Board Component Location



(Figure 5.3) Main PC Board Component Location

SECTION VI

REPLACEABLE PARTS

6.1 INTRODUCTION.

6.2 This section contains information for ordering replacement parts for the Model 429 Defibrillator Energy Meter.

6.3 Table 6-1 lists replaceable parts in alphanumerical order to their circuit symbols. Detailed information on a part used more than once in the instrument is listed opposite the first circuit symbol applying to the part. Other circuit symbols applying to the same part refer to the initial symbol. Detailed information includes the following:

1) Circuit symbol.

2) Full description of part.

3) Manufacturer of part.

4) Manufacturer's part number.

5) Total quantity used in the equipment.

6.4 ORDERING INFORMATION.

6.5 Most of the parts listed in the parts list can be secured from local electronic parts houses. If this is not feasible or a part needs replacing that is not listed, address order or inquiry to:

Customer Service
R. H. DEMPSEY MFG. COMPANY
P. O. Box 2339
Napa, California 94558
(707) 255-6767

Specify the following information for each part:

1) Model and complete serial number on instrument.

2) Circuit symbol.

3) Manufacturer of part.

4) Manufacturer's part number.

5) Description.

6.6 To order a part not listed in Table 6-1, give a description of the part and include its function and location.

TABLE 6-1 Replaceable parts continued

CIRCUIT SYMBOL	DESCRIPTION	MFG.	MFG. NO.	TR.
A1	Multiplier	Motorola	MC 1494	1
A2	Op-Amp	N. S. C.	LM 301AN	2
A3	Voltage Comp.	N. S. C.	LM 311	1
A4	Same as A2			
C1	Capacitor Ceramic 0.01 MFD 3000V	Sprague	30GA-S10	2
C2	Same as C1			
C3	Capacitor Electrolytic 150 MFD 25VDC	Sprague	TE 1212	2
C4	Same as C3			
C5	Capacitor Tantalum 3.3 MFD 15VDC	Kemet	K3R3C15K	4
C6	Same as C5			
C7	Same as C5			
C8	Same as C5			
C9	Capacitor Mica 30 PF 500VDC	Elmenco	DM-15-300J	2
C10	Capacitor 0.01 MFD 200V	Sprague	192P-10392	1
C11	Same as C9			
C12	Capacitor 0.47 MFD 50V	C. D. E.	WCR-05P47	1
C13	Capacitor Tantalum 12 MFD 20V	Kemet	K12C20K	1
C14	Capacitor 0.001 MFD 200V	Sprague	192P-10292	3
C15	Same as C14			
C16	Same as C14			
C17	Capacitor 0.22 MFD 200V	Sprague	192P-10492	1
C18	Capacitor Mica 75 PF 500V	Elmenco	DM-15-750J	1

TABLE 6-1 Replaceable parts continued

CIRCUIT SYMBOL	DESCRIPTION	MFG.	MFG. NO.	TR.
D1	Diode Bridge 1A 50VP1V	Motorola	MDA920A-2	2
D2	Same as D1			
D3	Diode Zener IN821A			1
D4	Diode Zener IN5240B	Motorola	IN5240B	1
D5	Diode IN4727			4
D6	Diode IN198A			1
D7	Same as D5			
D8	Same as D5			
D9	Same as D5			
F1	Fuse 1/2A 3AG			1
XF1	Fuse Holder	Littlefuse	342014	1
I1	Pilot Light, Neon	Eldema	CG03-RCS-N120	1
XI1	Pilot Light Socket	Eldema	DH0-10B-Di4B	1
J1	Coax Jack	Amphenol	UG-1094/V-1050	1
K1	Knob	Raytheon	407D2K1	1
M1	Meter	R.H.Dempsey Mfg. Co.	100171	1
Q1	Transistor 2N3053			2
Q2	Transistor FET 2N5459			1
Q3	Transistor MPS 6521			3

TABLE 6-1 Replaceable parts continued

CIRCUIT SYMBOL	DESCRIPTION	MFG.	MFG. NO.	TR.
Q4	Same as Q3			
Q5	Same as Q1			
Q6	Transistor 2N4123			8
Q7	Same as Q6			
Q8	Same as Q6			
Q9	Not Used			
Q10	Transistor FET 2N4093			1
Q11	Transistor 2N5458			1
Q12	Same as Q6			
Q13	Same as Q6			
Q14	Same as Q6			
Q15	Same as Q6			
Q16	Transistor U.J.T. 2N4871			1
Q17	Transistor 2N4125			2
Q18	Same as Q6			
Q19	Same as Q3			
Q20	Same as Q17			
R1	Resistor Composition 33K ± 5% 1/2W			1
R2	Resistor Composition 1K ± 5% 1/4W			1
R3	Resistor Composition 1.5K ± 5% 1/4W			1
R4	Resistor Composition 100K ± 5% 1/4W			3
R5	Resistor Composition 150K ± 5% 1/4W			2
R6	Resistor Composition 68K ± 5% 1/4W			1

TABLE 6-1 Replaceable parts continued

CIRCUIT SYMBOL	DESCRIPTION	MFG.	MFG. NO.	TR.
R7	Resistor Composition 4.3K ± 5% 1/4W			1
R8	Resistor Variable 500 Ω	Helipot	62PR-500	1
R9	Resistor Composition 3K ± 5% 1/4W			5
R10	Resistor Composition 1.1K ± 5% 1/4W			1
R11	Resistor Composition 33K ± 5% 1/4W			1
R12	Resistor Composition 20K ± 5% 1/4W			2
R13	Resistor Composition 18K ± 5% 1/4W			1
R14	Resistor M.F. 10.0K ± 1% 1/8W	Corning	NA55-1002	2
R15	Same as R14			
R16	Resistor Composition 510 Ω ± 5% 1/4W			6
R17	Same as R16			
R18	Resistor M.F. 30.1K ± 1% 1/8W			1
R19	Resistor M.F. 61.9K ± 1% 1/8W			1
R20	Resistor M.F. 16.2K ± 1% 1/8W			1
R21	Resistor M.F. 2.94K ± 1% 1/8W			2
R22	Same as R21			
R23	Resistor Variable 5K	Helipot	76PR 5K	2
R24	Same as R23			
R25	Resistor Variable 20K	Helipot	76PR 20K	1
R26	Resistor Variable 1K	Helipot	62PR 1K	1
R27	Resistor M.F. 47.5K ± 1% 1/8W			1
R28	Resistor Composition 56K ± 5% 1/4W			4
R29	Same as R16			
R30	Resistor Composition 10K ± 5% 1/4W			1
R31	Same as R28			

TABLE 6-1 Replaceable parts continued

CIRCUIT SYMBOL	DESCRIPTION	MFG.	MFG. NO.	TR.
R32	Resistor M.F. 3.40K ± 1% 1/8W			1
R33	Resistor Composition 2.2M ± 5% 1/4W			1
R34	Same as R4			
R35	Same as R16			
R36	Resistor Variable 20K	Helipot	62PR 20K	1
R37	Resistor Composition 75K ± 5% 1/4			1
R38	Same as R16			
R39	Same as R5			
R40	Resistor M.F. 8.06K ± 1% 1/8W			1
R41	Resistor Composition 150Ω ± 5% 1/4W			1
R42	Resistor Composition 4.7K ± 5% 1/4W			3
R43	Same as R42			
R44	Same as R9			
R45	Same as R9			
R46	Same as R28			
R47	Same as R28			
R48	Same as R9			
R49	Same as R42			
R50	Same as R5			
R51	Resistor Variable 200K	Helipot	62PR 200K	1
R52	Same as R16			
R53	Resistor Composition 15Ω ± 5% 1/4W			1
R54	Resistor Composition 47K ± 5% 1/4W			2
R55	Same as R12			
R56	Same as R54			

TABLE 6-1 Replaceable parts continued

CIRCUIT SYMBOL	DESCRIPTION	MFG.	MFG. NO.	TR.
R57	Resistor Composition 8.2K ± 5% 1/4W			1
R58	Resistor Composition 5.1K ± 5% 1/4W			3
R59	Resistor Composition 200K ± 5% 1/4W			2
R60	Resistor Composition 16K ± 5% 1/4W			1
R61	Same as R9			
R62	Resistor Composition 3.3K ± 5% 1/4W			1
R63	Resistor Composition 13K ± 5% 1/4W			1
R64	Resistor Composition 1.3K ± 5% 1/4W			1
R65	Same as R58			
R66	Same as R59			
R67	Same as R4			
R68	Resistor Composition 2K ± 5% 1/4W			1
R69	Same as R58			
R70	Not used			
R71	Resistor M.F. 196K ± 1% 1/4W			4
R72	Same as R71			
R73	Same as R71			
R74	Same as R71			
R75	Resistor M.F. 205K ± 1% 1/4W			1
R76	Resistor M.F. 3.65K ± 1% 1/4W			1
R77	Resistor M.F. 3.16K ± 1% 1/4W			2
R78	Same as R77			
R79	Resistor Composition 2M ± 5% 1/2W			5
R80	Same as R79			
R81	Same as R79			

TABLE 6-1 Replaceable parts continued

CIRCUIT SYMBOL	DESCRIPTION	MFG.	MFG. NO.	TR.
R82	Same as R79			
R83	Same as R79			
R84	Resistor Composition 10K ± 5% 1/2W			1
R85	Resistor Composition 18K ± 5% 2W			6
R86	Same as R85			
R87	Same as R85			
R88	Same as R85			
R89	Same as R85			
R90	Same as R85			
S1	Power Switch	Alcoswitch	MST105D	1
S2	Range Switch	R.H.Dempsey	100173	1
T1	Power Transformer	R.H.Dempsey	100174C	1
Z_1	R.F.I. Filter	R.H.Dempsey	100179	1
Z_2	Trigger Network	R.H.Dempsey	100181	1